National Aeronautics and Space Administration˚
Aerospace Vehicle Systems Technology Office
Langley Research Center
Hampton, Virginia 23681

NASA Explores Personal Air V
That Can Dramatically Improve Mobility

Personal Air Vehicles offer the potential for a breakthrough in mobility, capacity, congestion, and quality of life through the development of an on-demand aerial transportation system.

In a combined effort NASA, industry and universities have identified the missions, technologies and concepts that can lay the foundation for viable future products and a vibrant new market.

The objective of this NASA research is to enable safe, affordable, easy-to-use, and acceptable personal air vehicles through new technologies. The results will provide expanded access to more communities for a broad segment of the American public; empowering much greater reach, flexibility, freedom, speed, and transportation system robustness than the current hub and spoke or highway transportation systems.

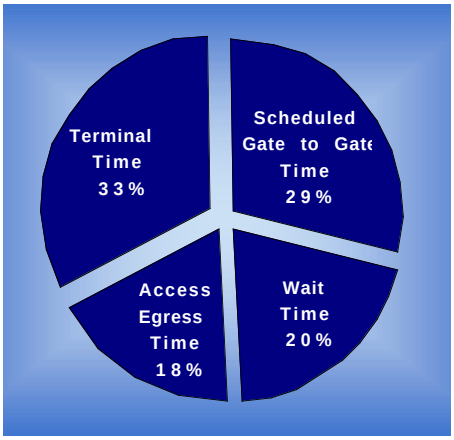
NASA's Aeronautics Blueprint outlines diverse future aviation mobility solutions for transportation

Personal Air Vehicles (PAVs) are envisioned as the next logical step in the natural progression in the nation s history of disruptive transportation system innovations. As the automobile improved quality of life and standards of living in the 20th century, PAVs are envisioned to do likewise in the 21st century. PAVs are defined as self-operated aircraft, capable of use and affordable by a large portion of the general public. The goal of these vehicles is to provide a breakthrough in personal air mobility, through dramatic time-savings and increased reach, and therefore a greatly improved quality of life. There are two key questions involving the future viability of PAVs. First, is there a significant potential benefit in developing such a capability. Second, is such a transportation system affordable and technically possible. An understanding of the current state of mobility is required prior to proposing any improvements, or understanding comparative benefits between competing systems.

PAVE PERSON

Current State of Mobility

Currently most aviation travel is performed through a centralized hub and spoke system, in fact, 75% of all aviation passenger traffic is conducted through only the 30 busiest airports. Certainly the hub and spoke system will continue to be a vital asset for long distance travel, with continued NASA investment in efficiency and environmental technologies.˚ However, the current hub and spoke system doesn't serve rural, regional, and intra-urban travel very effectively. For travel distances of 100 to 500 miles consumers still choose to use automobiles 20x more often than aircraft.˚



Obviously there is a key difference between airlines, which operate in a centralized hub and spoke infrastructure, and autos or future PAVs, which operate in a highly distributed infrastructure that offers closer proximity to destinations. The result is significantly less burden than centralized services (driving many miles to reach a hub, arriving early for ticketing, security, baggage checks, connections through other hubs, etc). A current study being conducted by the Department of Transportation s Volpe Center in cooperation with NASA shows that only 29% of the total door-to-door trip time is the actual gate-to-gate time of the airliner for trips under 500 miles. PAVs offer the ability to avoid much of the delays and let you travel when and where you want.

Automobiles are the dominant method of travel today, even for long distance trips. Autos capture 76% of all trips greater than 100 miles, while airlines capture only 19%. Considering that the average auto speed is only 35 mph; and that projected congestion over the next 25 years will dramatically reduce this speed even further, there is the need for faster travel that can avoid the gridlock of either highways or hub and spoke airports. However, there are good reasons why Personal Air Vehicles are currently limited to General Aviation enthusiasts, and are not part of a viable transportation system embraced by the public. Significant technology and socio-economic challenges prevent the free market from capitalizing on large market demand and public interest.

Considering the true door-to-door block time, on-demand PAVs have the potential to achieve a daily mobility reach of 150 to 300 miles, providing a five to ten fold increase over the automobile today. Imagine the last 100 years without the ten-fold increase the automobile provided over the horse and buggy, and the limiting effect this would have had on the economy. Mobility is a driving force in economic prosperity, permitting expansion into underutilized resources.

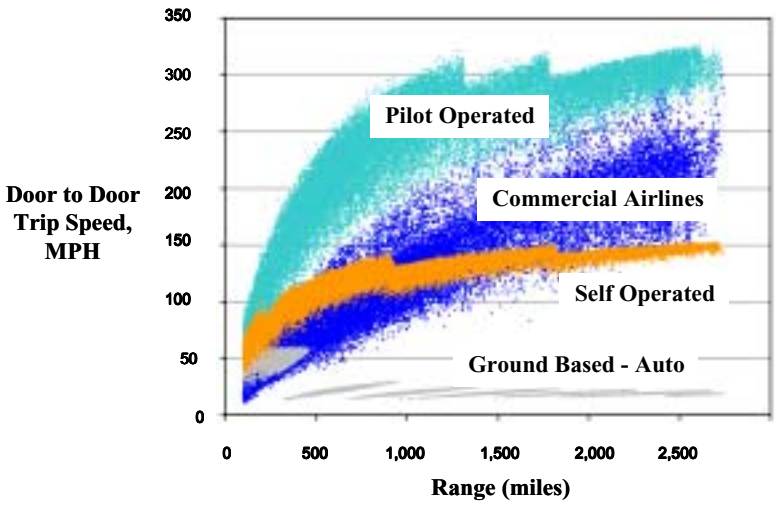
Future State of Mobility

An on-demand aviation system, with self-operated small aircraft that are as easy to fly, comfortable, affordable, environmentally friendly, safe, reliable, and as quiet as driving a car. has been a future vision shared by the Wright Brothers, Henry Ford, and many dreamers along the path of aviation. This capability to travel faster, further, anytime, anywhere is a dream that that could lead us into a new age of mobility. However, small aircraft currently lack basic utility and are too expensive, noisy, uncomfortable, difficult to operate and unreliable to generate a rational travel market.

PAVs would operate in the near-term from the current base of 5300+ public and 5000+ private general aviation airports. This number excludes the nearly 10,000 additional heliports that are available, with many of these locations coincident to hospitals. PAVs would not operate out of the busiest 100 public airports, which comprises the hub and spoke system. Essentially, the infrastructure already exists today to support a distributed PAV transportation system, at least in terms of land use. Typically one of the largest hurdles in developing a radical improvement in society is the development of the new infrastructure. In the case of PAVs, the infrastructure is simply drastically underutilized.

The technology challenges that must be surmounted to support rural and regional missions include ease of use, automated airspace control, affordable propulsion, economically viable concepts, low community noise, modern certification procedures, and near all weather capability while achieving a factor of ten improvement in small aircraft safety. Intra-urban mission technologies that are required include improved propulsion system thrust to weight, increased efficiency, simple yet effective high-lift systems with low-speed control, powered-lift innovations, lightweight structures, and the ability to convert alternative energy sources to thrust.

The investment in small aircraft vehicle technologies is one sector of the Aerospace Vehicle Systems Technology Program. PAV technologies offer the opportunity to make small aircraft much better than they are today, and to develop an on-demand transportation system that would be much faster and provide more throughput than what we have today. This new travel choice could make our children think we were as archaic standing beside our beloved Chevrolet as we know our great grandfathers were as they proudly rode their steed into town



PERSONAL AIR VEHICLE EXPLORATION

Personal Air Vehicle 25 Year Proposed Timeline

Year	Key Activity
2003	Completion of 3 Year PAVE system study establishes targets and goals for technologies
2004	Low cost and low noise ducted propeller propulsion system technology demonstration
2005	Small Aircraft Transportation System (SATS) prototype airspace and service demonstration
2006	Introduction of low cost, 4-6 passenger turbofan Air-Taxi s for initial on-demand piloted service
2007	Next Generation GA aircraft demonstrations (quiet ducted propulsion and low cost technologies)
2008	Automated weather and traffic avoidance en-route technology demonstrations
2009	Naturalistic Flight Deck cockpit demonstration (ease of use technologies with airborne internet)
2010	Military small platform VTOL concept demonstration (flying horse and mule analogy)
2011	Single pilot, All weather Air-Taxi operation FAA certification
2012	Quality Assurance (QA) based FAA design certification standards
2013	Highway in the Sky (HITS) initial deployment with airport information services
2014	FAA software certification standards released
2015	Gridlock Commuter aircraft demonstration (extreme STOL, low-speed, and side-street capability)
2016	Reduced licensing and training demonstrations with initial Flyer s Ed High School curriculum
2017	FAA Part 91A fully automated pilot operations certification standards released
2018	Introduction of automated pilot aircraft for self-operated service
2019	Low cost small turbine, high specific output propulsion system technology demonstration
2020	Simple, effective high-lift system technology demonstration
2021	VTOL Air-Taxi aircraft demonstration (robust propulsion and high payload fraction technologies)
2022	Introduction of Gridlock Commuter aircraft and initial development of ESTOL urban airfields
2023	Self healing and recovery systems technology demonstration
2024	Electric propulsion system technology demonstration
2025	Introduction of VTOL Air-Taxi aircraft with initial operations from hospital verti-ports
2026	Multi-functional and integrated structures technology demonstration
2027	FAA certification of autonomous operations
2028	Introduction of autonomous aircraft for self-operated service
2029	Simplified powered-lift system technology demonstration
2030	Annual production of PAVs exceeds 250,000 units per year (3% of automobile market)